



MEMORANDUM

DATE: June 20, 2005

SUBJECT: Population and Projection of Stationary Engines

FROM: Tanya Parise, Alpha-Gamma Technologies, Inc.

TO: Sims Roy, EPA OAQPS ESD Combustion Group

The purpose of this memorandum is to present the population of existing and projected number of new stationary compression ignition (CI) and spark ignition (SI) internal combustion engines. This memorandum will describe how the existing population and projected number of new CI and SI stationary engines were derived.

Introduction

The population of existing and projection of new engines were based on information from the Power Systems Research (PSR) 1998 North American Engine Partslink Data Base. This database was provided by the U.S. EPA's Office of Transportation and Air Quality (OTAQ) who has purchased the rights to use this database. The database contains population estimates for road and nonroad engines. The EPA determined that it would be appropriate to use the data developed by PSR in estimating the number of existing and new CI and SI stationary engines for several reasons. These reasons were presented in the memorandum entitled "Decision on Using Estimates from PSR or the RICE NESHAP Population Database for Engines above 500 Horsepower," which is included as Attachment A.

Existing Population of Engines

The existing population of engines in the U.S. was based on information from PSR's database. The most recent year for which population information was available from PSR's database was 1998. The information in PSR's database was separated by engine ignition type (CI and SI), size range, and by application type. The information from PSR includes both mobile and stationary engines so it was necessary to determine which applications can be used for stationary purposes and distinguish the actual fraction of engines used in stationary applications. The following are used in stationary applications:

- Generator Sets,
- Air Compressors,
- Pumps,
- Welders,
- Irrigation Sets,
- Hydro Power Units, and
- Gas Compressors.

For the development of OTAQ’s nonroad rule, a set of fractional splits for mobile engines was established for the PSR engine population information. The stationary fraction of engines was determined by subtracting the mobile fraction from 1. The stationary fraction applies to the total engine population as a function of horsepower (HP) rating. Table 1 shows the stationary fractions by HP range used to determine the number of stationary engines in PSR’s database. The fractions shown in Table 1 were also assumed to apply to the projected number of new engines, discussed in the next section of this memorandum.

Table 1. Stationary Fraction of Engines

HP Range	Stationary Fraction of Total Engines
50-100	0.30
100-175	0.80
175-300	0.85
300-600	0.90
600-750	1.0
>750	1.0

An assumption was made that there are no stationary engines smaller than 50 HP. This is consistent with other information EPA has reviewed including information gathered by the California Air Resources Board for the proposed Airborne Toxic Control Measure for stationary CI engines, which showed that no stationary engines below 25 HP were identified. In addition, other state rulemakings have used 50 HP as a cutoff for stationary engines. Therefore, only the stationary fractions for engines greater than 50 HP are shown in Table 1. The population of stationary CI and SI engines broken down by HP range is presented in Table 2.

Table 2. Population of CI and SI Stationary Engines (as of 1998)

HP Range	Population	
	CI	SI
50-100	124,064	44,872
100-175	197,076	53,983
175-300	130,744	13,583
300-600	140,058	6,502
600-750	24,359	1,027
>750	47,478	5,814
Total	663,780	125,780

Projection of New Engines

Engine sales information from PSR and information from the Engine Manufacturers Association (EMA) was used to project the number of new CI and SI engines from the years 2006 through 2017. The information from PSR did not contain any data on the population of CI engines above 3,000 HP, therefore EPA asked EMA to provide an estimate of the number of new engines above 3,000 HP. Joe Suchecki of EMA provided an estimate to Sims Roy of EPA in an email on April 28, 2005; this email can be found in the docket for the New Source Performance Standards for stationary CI engines (Docket Number OAR-2005-0029). The EMA estimated that approximately 160 stationary CI engines larger than 3,000 HP are sold each year. This estimate is included in the number of engines shown in Table 3.

As with the existing population of engines from PSR, the engine sales information from PSR also included both mobile and stationary engines and all applications. To determine the number of stationary engines sold, the stationary fractions listed in Table 1 were applied to total engine sales of applications used for stationary purposes. It was also assumed that there would not be many (if any) stationary engines less than 50 HP sold. The number of projected new CI engines sold was estimated based on PSR engine sales from the years 1990 through 2000. The difference in engine sales from one year to the next was calculated for each HP range to obtain an average increase in engine sales over the 10 year period per HP range. The average increase in sales over the 10 year period was added to the 2000 engine sales to project engine sales in 2001. The average increase in sales over the 10 year period was added to the projected number of engines sold in 2001 to obtain estimates of engine sales in 2002, and so on to reach the 2006 through 2017 timeframe.

A similar methodology was followed to estimate the number of new SI engines, although less recent sales data were available for SI engines. The most recent year of sales available for SI engines from PSR's database was 1998. The projected number of new CI engines and SI engines is presented in Tables 3 and 4, respectively.

Table 3: Projected Number of New CI Engines by HP Range from 2006 through 2017

HP Range	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
50-100	17,669	18,432	19,194	19,956	20,719	21,481	22,243	23,006	23,768	24,530	25,293	26,055
100-175	16,292	16,846	17,400	17,954	18,507	19,061	19,615	20,168	20,722	21,276	21,829	22,383
175-300	15,825	16,506	17,187	17,868	18,549	19,230	19,911	20,592	21,273	21,954	22,635	23,316
300-600	6,181	6,345	6,510	6,674	6,839	7,004	7,168	7,333	7,498	7,662	7,827	7,991
600-750	877	894	910	927	943	960	976	993	1,009	1,026	1,042	1,059
>750	4,150	4,276	4,402	4,529	4,655	4,781	4,908	5,034	5,160	5,287	5,413	5,539
Total	60,994	63,298	65,602	67,907	70,212	72,516	74,820	77,125	79,429	81,734	84,038	86,343

Table 4: Projected Number of New SI Engines by HP Range from 2006 through 2017

HP Range	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
50-100	5,940	6,134	6,327	6,520	6,713	6,906	7,099	7,293	7,486	7,679	7,872	8,065
100-175	7,499	7,555	7,611	7,667	7,723	7,779	7,836	7,892	7,948	8,004	8,060	8,116
175-300	1,774	1,844	1,915	1,986	2,056	2,127	2,198	2,269	2,339	2,410	2,481	2,552
300-600	797	824	851	879	906	933	960	988	1,015	1,042	1,070	1,097

600-750	55	51	48	45	41	38	35	32	28	2
>750	1,955	2,051	2,146	2,242	2,337	2,433	2,528	2,624	2,719	2,815
Total	18,019	18,459	18,898	19,338	19,777	20,217	20,656	21,096	21,535	21,974

The engine sales information from PSR used to project the number of new SI engines from 2006 through 2017 was not broken down into engine type. The EPA consulted information developed for the national emission standards for hazardous air pollutants (NESHAP) for stationary reciprocating internal combustion engines (RICE). The EPA used the breakdown of SI engines in the projected number of new SI RICE developed for the RICE NESHAP. That information contained a breakdown of SI engine types, i.e., 2 stroke lean burn (2SLB), 4 stroke lean burn (4SLB), and 4 stroke rich burn (4SRB), for engines greater than 500 HP. It was assumed that the breakdown by engine type for engines in the 50 to 500 HP range obtained from PSR is the same as the breakdown by engine type for engines between 500 and 1,000 HP obtained from information developed for the RICE NESHAP. The percent each SI engine type represents out of the total number of SI engines is shown in Table 5.

Table 5: Percentage Each Engine Type Represents out of Total SI Engines

HP Range	Percent of Total SI Engines		
	2SLB	4SLB	4SRB
50-1,000	11%	47%	42%
1,000-5,000	None	59%	41%
5,000-10,000	None	50%	50%

The projected number of new SI engines broken down by engine type is presented in Tables 6 through 8.

Table 6: Projected Number of New 2SLB Engines by HP Range from 2006 through 2017

HP Range	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
50-100	653	675	696	717	738	760	781	802	823	845	866	887
100-175	825	831	837	843	850	856	862	868	874	880	887	893
175-300	195	203	211	218	226	234	242	250	257	265	273	281
300-600	88	91	94	97	100	103	106	109	112	115	118	121
600-750	6	6	5	5	5	4	4	3	3	3	2	2
>750	44	46	48	50	52	54	56	58	60	62	64	66
Total	1,811	1,851	1,891	1,931	1,971	2,010	2,050	2,090	2,130	2,170	2,209	2,249

Table 7: Projected Number of New 4SLB Engines by HP Range from 2006 through 2017

HP Range	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
50-100	2,792	2,883	2,974	3,064	3,155	3,246	3,337	3,427	3,518	3,609	3,700	3,791
100-175	3,525	3,551	3,577	3,604	3,630	3,656	3,683	3,709	3,735	3,762	3,788	3,814
175-300	834	867	900	933	967	1,000	1,033	1,066	1,100	1,133	1,166	1,199
300-600	375	387	400	413	426	439	451	464	477	490	503	516
600-750	26	24	23	21	19	18	16	15	13	12	10	9
>750	1,105	1,159	1,213	1,268	1,322	1,376	1,430	1,485	1,539	1,593	1,647	1,701

Total	8,655	8,871	9,087	9,303	9,519	9,735	9,951	10,166	10,382	10,598	10,814	11,030
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Table 8: Projected Number of New 4SRB Engines by HP Range from 2006 through 2017

HP Range	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
50-100	2,495	2,576	2,657	2,738	2,819	2,901	2,982	3,063	3,144	3,225	3,306	3,387
100-175	3,150	3,173	3,197	3,220	3,244	3,267	3,291	3,315	3,338	3,362	3,385	3,409
175-300	745	775	804	834	864	893	923	953	982	1,012	1,042	1,072
300-600	335	346	358	369	380	392	403	415	426	438	449	461
600-750	23	22	20	19	17	16	15	13	12	10	9	8
>750	806	845	884	924	963	1,002	1,042	1,081	1,120	1,160	1,199	1,238
Total	7,553	7,736	7,920	8,104	8,288	8,472	8,655	8,839	9,023	9,207	9,391	9,574

ATTACHMENT A



MEMORANDUM

DATE: June 22, 2004

SUBJECT: Decision on Using Estimates from PSR or the RICE NESHAP Population Database for Engines above 500 Horsepower

FROM: Melanie Taylor and Chuck Zukor, Alpha-Gamma Technologies, Inc.

TO: Sims Roy and Jaime Pagán, EPA OAQPS ESD Combustion Group

The purpose of this memorandum is to provide a recommendation of which data source to use for estimating the population of existing and new stationary RICE above 500 hp for both the NSPS and 112(k) rule development. The options are to use the data from the PSR database provided by OTAQ, or the estimates of existing and new engines developed for the RICE NESHAP. Alpha-Gamma has analyzed the 1998 PSR data provided by OTAQ for spark ignition (SI) population and sales and compression ignition population, and the 2000 PSR data for CI sales.

A comparison of the PSR data with the RICE NESHAP estimates shows that the estimates for CI RICE vary significantly. The PSR data indicate approximately eight times more existing CI RICE above 500 hp than accounted for in the RICE NESHAP database. Projections of new CI RICE above 500 hp based on the PSR sales data are approximately 3.5 times those used for the RICE NESHAP. For SI RICE, the PSR data indicate fewer existing engines above 500 hp than the RICE NESHAP database (~9,000 for PSR and ~13,000 for RICE NESHAP database). The projections of new SI RICE above 500 hp are fairly similar for both PSR and the RICE NESHAP.

Alpha-Gamma recommends using the PSR data instead of the RICE NESHAP estimates for the following reasons:

- Alpha-Gamma's rationale for using the RICE NESHAP data above 500 hp for the area source population was based primarily on using consistent data/methods in the development/integration of the 112(k) and NESHAP rules. However, the PSR data were not available in time to affect the RICE NESHAP (which is now final). Thus, EPA may consider any new and enhanced data sources to develop the 112(k) and NSPS rules.

- The inventory numbers that CARB has show more than 5,000 CI engines that are greater than 500 hp, of which 4,270 are above 750 hp and are therefore based on actual permit inventory. Using the numbers for the NESHAP, we would approximate about 14,000 existing CI engines above 500 hp nationwide. Comparing that to the CARB number makes Alpha-Gamma believe the NESHAP estimate is low, since it is doubtful California has a third of the CI engines in the U.S.
 - Note that CARB concluded that the PSR database underestimated the number of CI engines greater than 750 hp. They said that their district permit data were assumed to be more representative of the numbers of large engines (greater than 750 hp) and the PSR data were used to allocate smaller engines (less than 750 hp).
- The NESCAUM report has a table of permitted CI engines in the northeast states (actual engines, not PSR estimates), and it shows more than 5,000 engines above 500 hp. Adding that to the CARB inventory totals to more than 10,000 existing CI engines just in California and the northeast. Comparing that to the total NESHAP estimate of 14,000 would appear to justify the argument that the NESHAP estimate is not accurate and underestimates the population.

One potential explanation for the large difference in CI RICE population counts is that the RICE NESHAP Population Database is only representative of permitted engines. For example, it is possible that most of the “unaccounted” CI RICE are in emergency use applications, thus they do not appear in permits.